

**Syllabus for Entrance Test  
For Admission to M. Phil, Ph.D. Courses and for the  
University Research Scholarship in Statistics**

Duration: 90 Minutes  
No. of Questions: 100

Maximum Marks: 100

Probability Theory, Standard discrete and Continuous distributions. Sampling distributions. Standard errors and asymptotic distributions, distribution of order statistics and range. Simple, Partial and Multiple Correlation Coefficients and related tests, Simple and multiple linear regression.

Methods of estimation. Properties of estimators. Confidence intervals, Testing of hypotheses. Tests of Significance: Small and Large sample tests. Analysis of discrete data and chi-square test of goodness of fit. Simple nonparametric tests for one and two sample problems.

Gauss-Markov models, Analysis of variance and covariance. Fixed, random and mixed effects models. Sampling and Designs of Experiments.

Multivariate Analysis, Data reduction techniques: Principle component analysis, Discriminant analysis, Canonical correlation.

Stochastic Processes and Queueing Theory-Basics of queues and Markov chains, Markov Process.

Numerical Analysis: Numerical solutions of algebraic and transcendental equations. Regula-falsi Method, Method of iteration and Newton-Raphson method, Rate of convergence, Finite differences, Interpolation for equal and unequal spaced interval, Numerical differentiation and integration, Numerical solutions of ODEs using. Picard, Euler, modified Euler and Runge-Kutta methods.

Linear programming problem: Simplex methods, duality.

Linear Algebra: Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations. Eigenvalues and eigenvectors, Quadratic forms, reduction and classification of quadratic forms.

Complex Analysis: Analytic functions, Cauchy-Riemann equations. Contour integral, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem, Maximum modulus principle, Schwarz lemma, Taylor series, Laurent series, calculus of residues.

Note: The syllabus for entrance test will be based on the syllabi of M.Sc. (Mathematical Statistics)

## Scheme of Examination for M. Phil (Statistics) 2010-11

The duration of the course of instruction of M. Phil (Statistics) Degree shall be one year (Two semesters). There will be three theory paper each of 100 marks in 1<sup>st</sup> Semester and two theory paper each of 100 marks in 2<sup>nd</sup> Semester. There will be dissertation of 200 marks to be submitted by the candidate during the course of Study. The detailed Scheme of the course is given below:

**M. Phil I<sup>st</sup> Semester**                      Common with course work of Ph.D.

Name of Paper	Theory	Internal Assessment	Time Allowed	Teaching Hrs. per week
Paper-I Research Methodology	80	20	3 hrs.	04
Paper-II & III	Any two of the following:			
Opt. (i) Stochastic Processes	80	20	3 hrs.	04
Opt. (ii) Advanced Theory of Sample Surveys	80	20	3 hrs.	04
Opt. (iii) Regression Analysis and Bayesian Inference	80	20	3 hrs.	04

**M. Phil II<sup>nd</sup> Semester**

Paper-IV, V	Any two of the following:			
Opt. (i) Reliability Theory and Modeling	80	20	3 hrs.	04
Opt. (ii) Statistical Genetics	80	20	3 hrs.	04
Opt. (iii) Information Theory	80	20	3 hrs.	04

The dissertation work for M. Phil will start in the I<sup>st</sup> Semester under the approved supervisor from amongst the members of the staff. The evaluation will be done by external examiner out of 150 marks. The viva-voce will be of 50 marks and will be conducted and evaluated by external examiner and supervisor. There will be internal assessment of 20 marks in each theory paper.

**M. Phil (Statistics) I<sup>st</sup> Semester**  
**Paper-I**  
**Research Methodology**

Maximum Marks: 80  
Time Allowed: 3 hrs.

**Unit-I**

Introduction: Meaning, objectives, types and significance of Research. Research Methods versus Methodology. Process of Research: Steps involved in research process, Research problem and its selection, Necessity of defining the problem, techniques involved in defining a problem with example.

Research Design: Meaning, Need, Feature and Importance of Research Design, various research designs.

**Unit-II**

Types of data and various methods of data collection, framing of questionnaire, check-list, concept of reliability and validity methods, compilation of data, coding, editing and tabulation of data, various sampling methods.

Random Number Generation, Mid-square method of Generating Pseudo-Random Numbers, Simulation techniques: Monte-Carlo Simulation and Applications.

Use of data analysis tools like SPSS, Minitab and MS Excel.

**Unit-III**

Statistical techniques for analyzing data: Measures of Central tendency measures of Dispersion, Importance of sampling distributions. Testing of Hypothesis: Parametric and Non-Parametric tests. Application of analysis of variance (ANOVA) and Covariance (ANCOVA).

**Unit-IV**

Preparation of Dissertation: Types and layout of Research, Precautions in preparing the research dissertation, Bibliography, reference and annexure, discussion of results, draug conclusions given suggestions and recommendations to the concerned persons.

**Books suggested:**

1. C.R. Kothari : Research Methodology (Wiley Eastern Publication)
2. J.K. Sharma : Operations Research
3. Goon, A.M., Gupta, : Fundamentals of Statistics (Vol. I and II)  
M.K. and B. Das Gupta

**M.Phil- I<sup>st</sup> Semester**  
**Paper II, III**  
**Opt. (i) Stochastic Processes**

Max Marks- 80  
Time- Three Hours

**Unit I**

Stochastic Processes, Random Walk model, Gambler's Ruin problem, Ballot Problem, Applications of Ballot problem, Generalized Random Walk.

**Unit II**

Continuous time Discrete State Markov Process, Population Models, Poison Process, Continuous Time and Continuous State Markov Process, Differentiation process, Kolmogorow backward and forward difference equation, Wiener Process, First passage Time distribution

**Unit-III**

Renewal theory, renewal equation, renewal theorems, Central limit theorem for renewal theory, Delayed and equilibrium renewal process, residual and excess life times renewal, renewal process.

**Unit IV**

Applications to population growth, Queuing models, Epidemic processes, simple epidemic, General epidemic, application in ecology, biology and sociology.

Books:

- |   |                      |   |
|---|----------------------|---|
| 1 | Baily, NTJ           | the Elements of Stochastic Processes        |
| 2 | Cox, DR & Miller, HD | The Theory of Stochastic Processes          |
| 3 | Basu AK              | Introductions to Stochastic Processes       |
| 4 | Medhi, J.            | Stochastic Processes                        |
| 5 | Bhatt, B.R.          | Stochastic Models, Analysis and Application |

Note: The examiner will set two questions from each section. The students are required to attempt five questions in all, selecting at least one question from each section.

**M.Phil-I<sup>st</sup> Semester**  
**Paper II, III**  
**Opt. (ii) Advanced Theory of Sample Surveys**

Max Marks- 80  
Time- Three Hours

**Unit –I**

Types of Sampling: Simple Random, Stratified Random and systematic sampling, Estimation in Ratio and Regression estimators, (For One and two variables), Double sampling for ratiom and regression estimators, double Sampling for stratification.

**Unit-II**

Sampling with varying probabilities, ordered and unordered estimators, Sampling Strategies due to Horvitz Thomson, Yales and Grundy Form Midzuno Sen, Brewerand Durbin Scheme (Sample size two only) Rao-Hartley, cochran Scheme for sample size n with random grouping and PPS systematic sampling, Double sampling for PPS estimation.

**Unit-III**

Single stage cluster sampling: multi-stage sampling, selection of PSU's with unequal probabilities, Selection of PSU with replacement, stratified multi-stage sampling, Estimation of ratios, choice of sampling and sdbusampling fraction, Repetitive Surveys, sampling on more than two occasions.

**Unit-IV**

Non-sampling errors, response errors, response bias, the analysis of data, Estimation of variance components uncorrelated response error, response and sampling variance, the problem of non-response, some example of sources of error. Variance estimation, method Estimation of random groups sub population. The best linear estimator two way stratification with small sample, variance estimation in multistage sampling, sampling inspections.

Books suggested

- |    |                        |   |
|----|------------------------|---|
| 1. | Chochran, W.G.         | Sample Techniques                             |
| 2. | Desrjv and Chandok     | Sampling Theory                               |
| 3. | Singh & Chaudhary F.S. | Theory and analysis of sample Survey designs. |
| 4. | Mukhopadhyay, Primal   | Inter Problems in survey sampling             |

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**M.Phil-I<sup>st</sup> Semester**  
**Paper: II, III**  
**(Opt.iii) Regression Analysis and Bayesian Inference**

Max Marks- 80  
Time- Three Hours

**Unit I**

Simple Linear Regression, Estimation of parameters, Matrix Approach to Linear Regression,  $R^2$  and adjusted  $R^2$ , Weighted Least Squares. Model Adequacy Checking – Residual Analysis, methods of scaling residuals- Standardized and studentized residuals Press Residual, Residual Plots, PRESS Statistic

**Unit II**

Diagnostics for Leverage and Influence, Variable Selection and Model Building, Computational Techniques for Model Selection- Mallow's  $C_p$ , Stepwise Regression, Forward Selection, Backward Elimination. Elementary Ideas of Logistic and Poisson regression

**Unit III**

Mixture Distributions, Exponential Family of distributions, Prior and Posterior distributions, Baye's theorem and computation of posterior distribution, Natural conjugate family of priors for a model, Conjugate families for exponential family models

**Unit IV**

Non – Informative and Improper priors, Jeffrey's Prior, Asymptotically Locally invariant prior. Maximum entropy priors, Bayes estimation.

**Books Recommended**

- Montgomery, D.C, Peck and Vining, G.G. (2002). Introduction to Linear Regression Analysis (John Wiley & Sons. )
- Draper, N.R. and Smith, H. (1981) Applied Regression Analysis (John Wiley & Sons)
- Robert, C.P. (2001): The Bayesian Choice: A Decision Theoretic Motivation (Springer Verlag New York)
- Sinha , S.K. (2004) Bayesian Estimation
- Berger, J.O. (1985) Statistical Decision Theory and Bayesian Analysis (Springer)

Note: The examiner will set two questions from each section. The students are required to attempt five questions in all, selecting at least one question from each section.

**M.Phil-2<sup>nd</sup> Semester**  
**Paper IV & V**  
**Opt. (i) Reliability Theory And Modeling**

Maximum Marks-80  
Time:-03 Hours

**Unit-I**

Reliability and Quality. Types of Reliability. Failures Data Analysis: Failure, Types of Failures, Causes of Failures, Failure Rate, Mean Time To Failure (MTTF), Mean Time Between Failures (MTBF), MTTF in terms of failure density. Hazard rate reliability in terms of hazard rate and failure density. Reliability Models: Constant Hazard Model, Linear and Non-Linear Hazard Model, The Weibull Model, Gamma Model, Normal Failure Model and Markov Model. Determination of Distribution functions and reliability of hazard models and Markov model.

**Unit-II**

System structures. Evaluation of mean time to system failure (MTSF) and reliability for various structures such as series, parallel, series parallel, parallel series, non-series parallel, mixed-mode and k-out-of-n structures. Methods of reliability improvement: Redundancy And Maintenance. Reliability analysis using redundancy and maintenance. Availability function.

**Unit- III**

Repairable Systems: Instantaneous repair Rate and Mean Time to Repair. Reliability and Availability Analysis of a Two-Unit parallel system with repair using markov model. Economics of Reliability Engineering: Manufactures cost, Customers cost, Reliability Achievement and utility cost Models, Depreciation cost models and Availability cost Model for parallel system. Availability Analysis of a system using renewal theoretic approach.

**Unit-IV**

Reliability and availability analysis of single-unit and two-unit cold standby systems with constant failure rate and repair using Regenerative Point and Supplementary Variable Techniques. Evaluation of reliability by the Methods-Decomposition method, Cut-set method, Event space method and Boolean function technique.

Parameters Estimation of Exponential, Gamma, Weibull, Normal and Lognormal Distributions (Two and Three Parameters) with Complete, Truncated and Censored Samples. Estimation by Components of order Statistics: k-Out of- n reliability estimation.

**Books Suggested:-**

- |    |                    |   |  |
|----|--------------------|---|--|
| 1. | Balagurusamy,E.    | : | Reliability Engineering  |
| 2. | Srinath, L.S.      | : | Reliability Engineering.   |
| 3. | Elsayed A. Elsayed | : | Reliability Engineering (Addison Wesley Longman. Inc. Publication                        |
| 4. | Sinha,S.K.         | : | Reliability and Life Testing.  |
| 5. | Birolini,A         | : | Reliability Engg.(Theory And Practice )  |
| 6. | Gurjar, Jai Singh  | : | Reliability Technology (I.K. International Publishing House Pvt. Ltd., New Delhi-110016) |

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## M.Phil-2<sup>nd</sup> Semester

### Paper IV &V

#### Opt. (ii) Statistical Genetics

Max Marks- 80  
Time- Three Hours

##### Unit-I

Basic terms and definition in genetics, Concepts of gene frequencies and their estimation, Mendal's Laws Linkage and crossing over. Statistical analysis for segregation: single factor segregation, two factors segregation, Heterogeneity chi-square, Detection and estimation of linkage for qualitative characters, Sex linked inheritance, gene action interaction, Multiple alleles, Pleiotropic action, lethal action, Mutation.

##### Unit-II

Random mating: Hardy- Weinberg equilibrium, Panmixia Population, Single locus, sex linked genes, Fisher's fundamental theorem of natural selection, forces affecting gene frequencies, selection, mutation and migration, equilibrium between forces in large population.

##### Unit-III

Polygenic system for quantitative characters: Polygenes, Major genes, Characterization of phenotypic value, Additive and genetic effects, Characterization of genotypic value, breeding value and dominance deviation, Determination of parameters of additive – dominance model.

##### Unit-IV

Components of variance and Genotypic variance, Components of Covariance, Correlations between relatives, Genetic parameters; Heritability, Repeatability and Genetic correlation, Relationship between them.

##### Books suggested:

Falconer, D.S.	Introduction to quantitative Genetics (Longman Group Ltd.)
Kempthorne, O (1953)	An Introduction to Genetical Statistics, Wiley Eastern
Prem Narain	Statistical Genetics, Wiley Eastern
Li, C.C.	Population Genetics, University of Chicago Press Cchieage & London
Jain, J.P.	Statistical Technique in Quantitative Genetics (Tata Mc Graw, Hill Publication Co. Ltd., New Delhi.

Note: The examiner will set two questions from each section. The students are required to attempt five questions in all, selecting at least one question from each section.

